How NIRB thermal imaging and IMAGEPro Glass could be a starter to decarbonize and improve your Carbon Footprint and Reduce NOx Emissions in Glass Furnaces

Glassman Asia 2023 - Seoul

LAND
AMETEK
PROCESS & ANALYTICAL INSTRUMENTS

Philippe Kerbois
Global Industry Manager - Glass

QUALITY CUSTOMER SOLUTIONS

SHORT INTRODUCTION

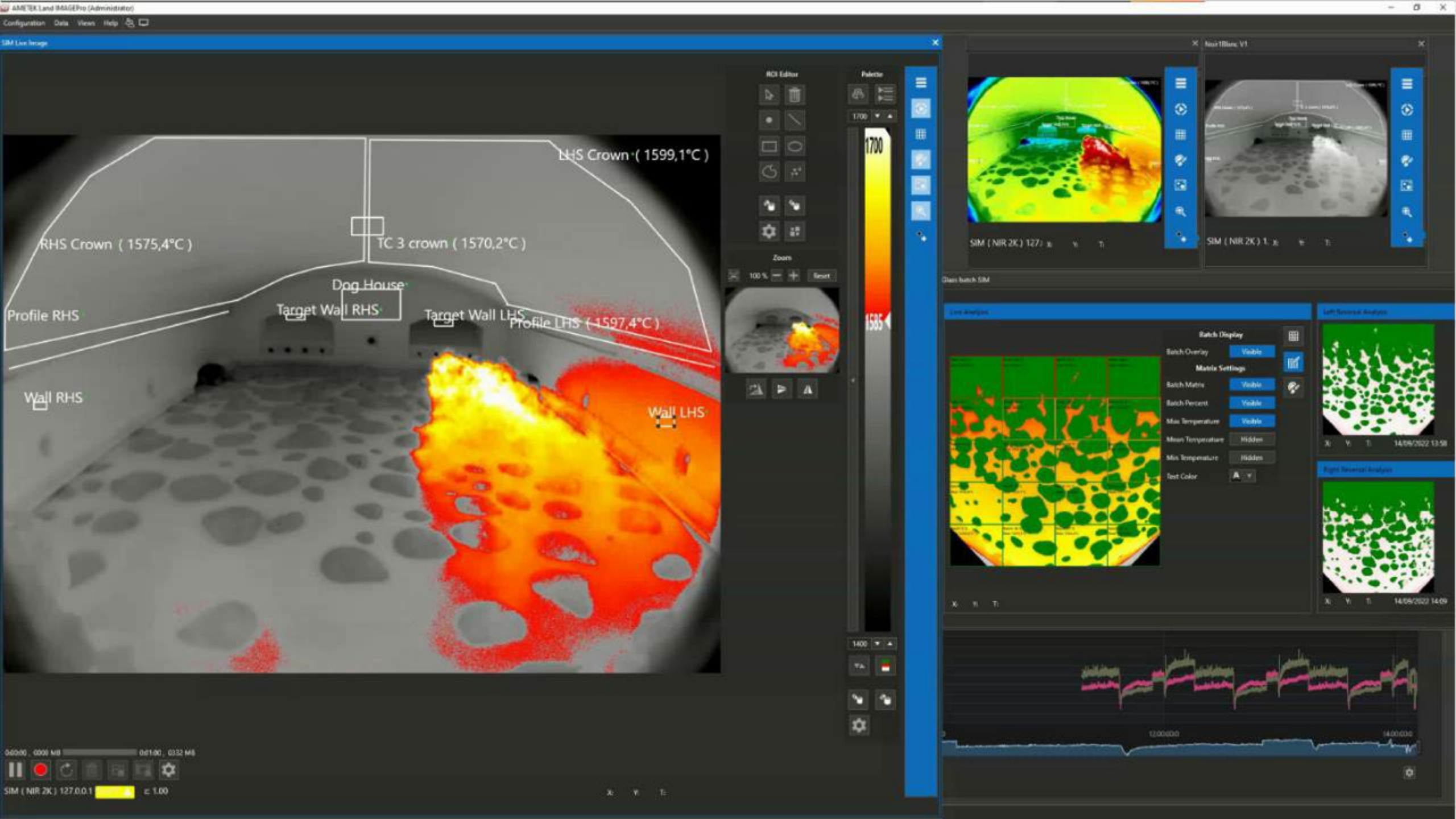
Philippe Kerbois

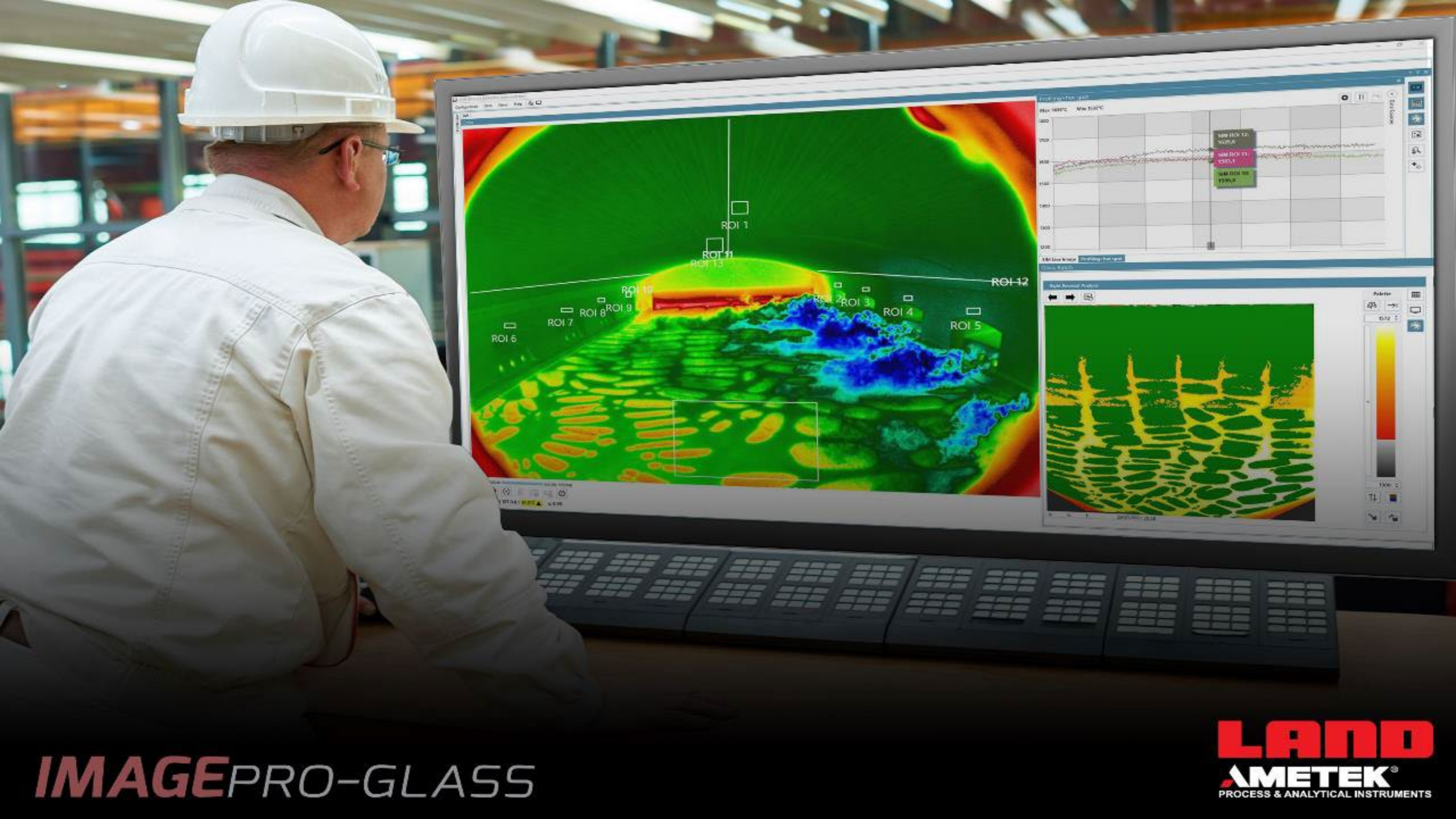
Global Industry Manager - Glass

- Philippe has extensive sales and project management experience from working in the steel, glass and automotive industries including Rockwell Automation and ABB where he was specifically involved in major robot-based factory automation projects.
- Having worked at AMETEK Land since 2012, Philippe initially managed the sales of infrared temperature measurement solutions into line builders and glass and steel furnace OEMs within France, however now he works very closely with the global glass market and is actively promoting the award-winning Near Infrared Borescope (NIR-B) Glass thermal imaging solution for glass furnaces.

philippe.kerbois@ametek.com
+33 (0) 6.75.38.39.87

NIRB Images in Glass Furnace


LHS Crown (1599,1°C)
RHS Crown (1575,4°C)
TC 3 crown (1570,2°C)
Dog House
Profile RHS
Target Wall RHS
Target Wall LHS
Profile LHS (1597,4°C)
Wall RHS
Wall LHS
1700
1585
1400
Batch Display
Batch Overlay
Visible
Matrix Settings
Batch Matrix
Batch Percent
Max Temperature
Mean Temperature
Hidden
Min Temperature
Text Color



IMAGEPRO-GLASS

LAND
AMETEK
PROCESS & ANALYTICAL INSTRUMENTS

LAND PORTFOLIO IN GLASS APPLICATIONS

Complete temperature offering

- Leverage demand for the NIRB borescope to promote a wider portfolio packages including :
  - The Fiber Optics “Legend FG”
  - Lancom 4 Gas analyser
  - FLTs and LSPHDs for thin bath and Lehrs
- As installation becomes more critical – possible to integrate and provide AMEcare Advanced Services into the offering
- Thermal Surveys with NIRB 2K demonstrating benefits of NIRB
- More than 150 NIRBs implemented Worldwide in major producers in the Glass industry

How NIRB thermal imaging and IMAGEPro Glass could be a starter to decarbonize and improve your Carbon Footprint and Reduce NOx Emissions in Glass Furnaces

Philippe Kerbois | AMETEK Land

Previous DGG/HVG Conference Papers:

- **2016** – Infrared temperature Measurement in Glass Melt Tanks
- **2017** – Controlling a Glass Furnace Using Thermal Imager
- **2018** – Infrared Temperature Measurement in Glass Melt Tank to optimize furnace operation & Nox
- **2019** – Criticality of Accuracy and Traceability of Temperature Calibration
- **2022** - Specific Energy Reduction through infra red furnace monitoring and optimisation

Equipment bundle Used:

NIR-B-2K-GLASS - Near Infrared Borescope Glass Solution

- 3,000,000 pixels each measuring temperature ≡ 3M Cyclops
- (Output of 100 x continuous measurement points via TCP/IP)
- Max, min and average temperatures with user defined emissivity.
- Patent Pending

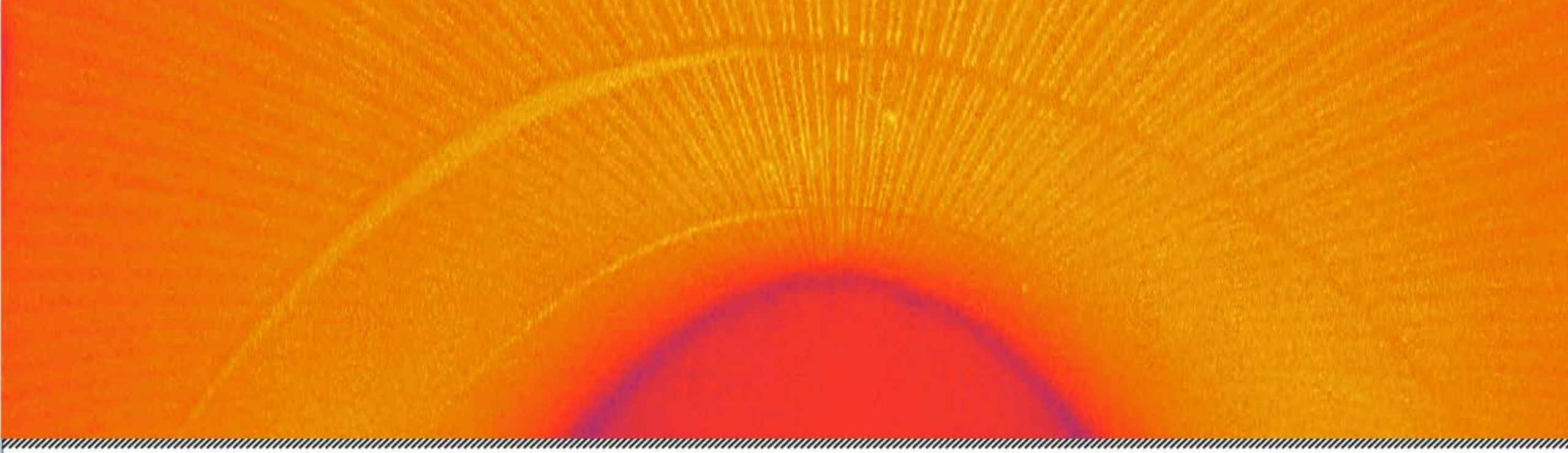
Cyclops C100L

- Portable Infrared Thermometer
- Industry Standard
- Verify spot temperatures
- 550 to 3000° C
- 1022 to 5432° F

Lancom 4 – Portable Gas Analyser

- 9 Gas Analyser for NOx
- CO low • CO high • O2
- NO • NO2 • NOx
- CO2 • H2S • SO2 • CxHy

QUALITY CUSTOMER SOLUTIONS

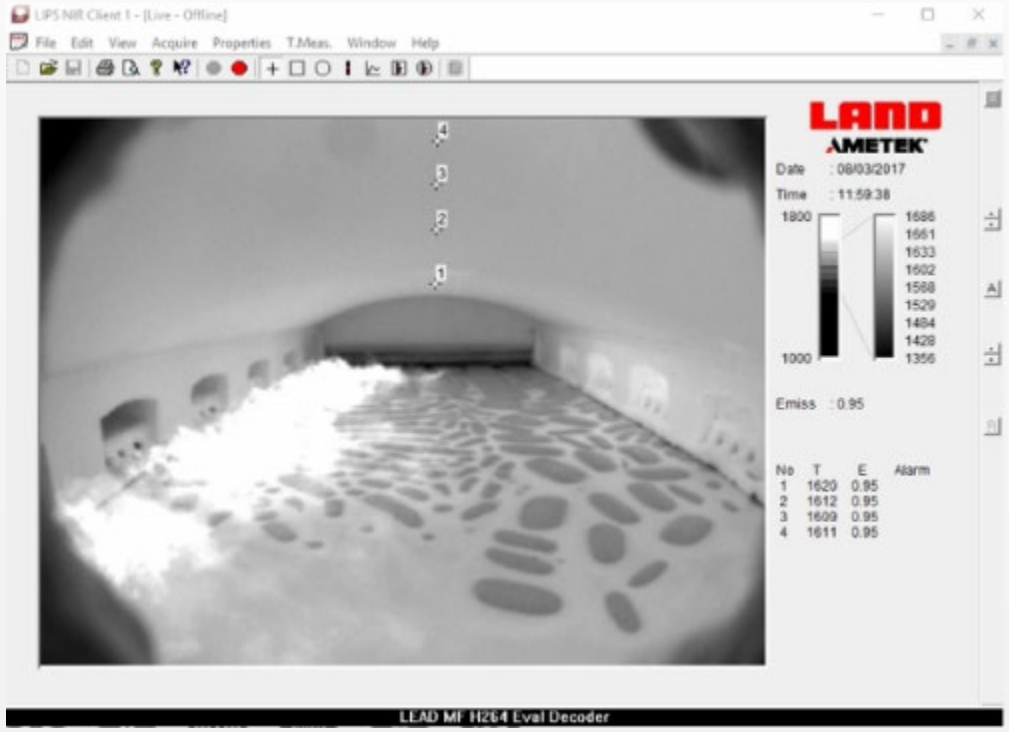


THE BENEFITS IN FURNACE OPERATIONS
“NOT JUST A PRETTY IMAGE”

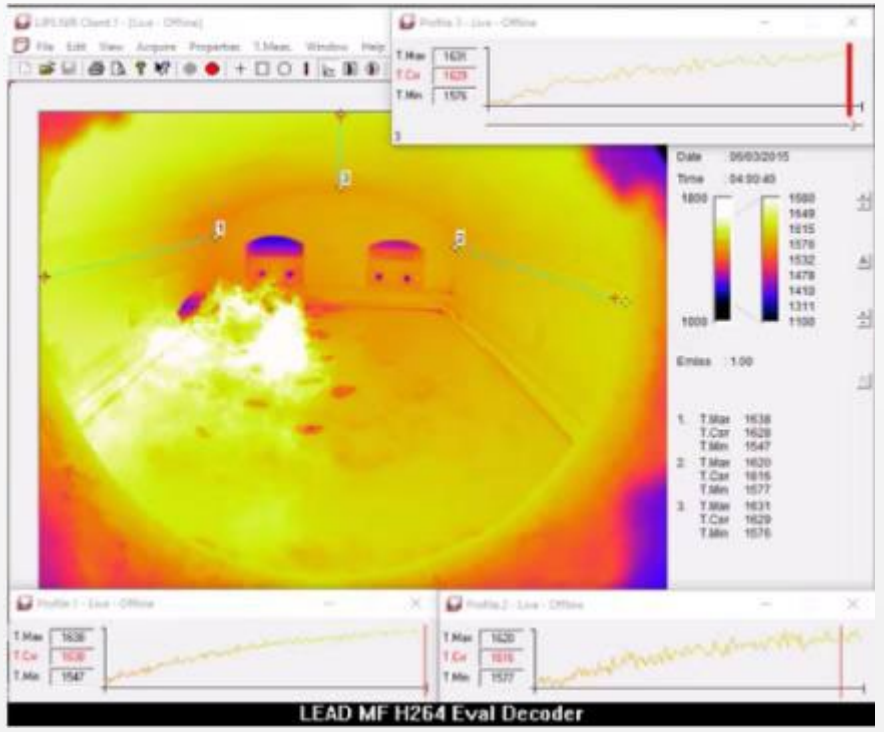
QUALITY CUSTOMER SOLUTIONS

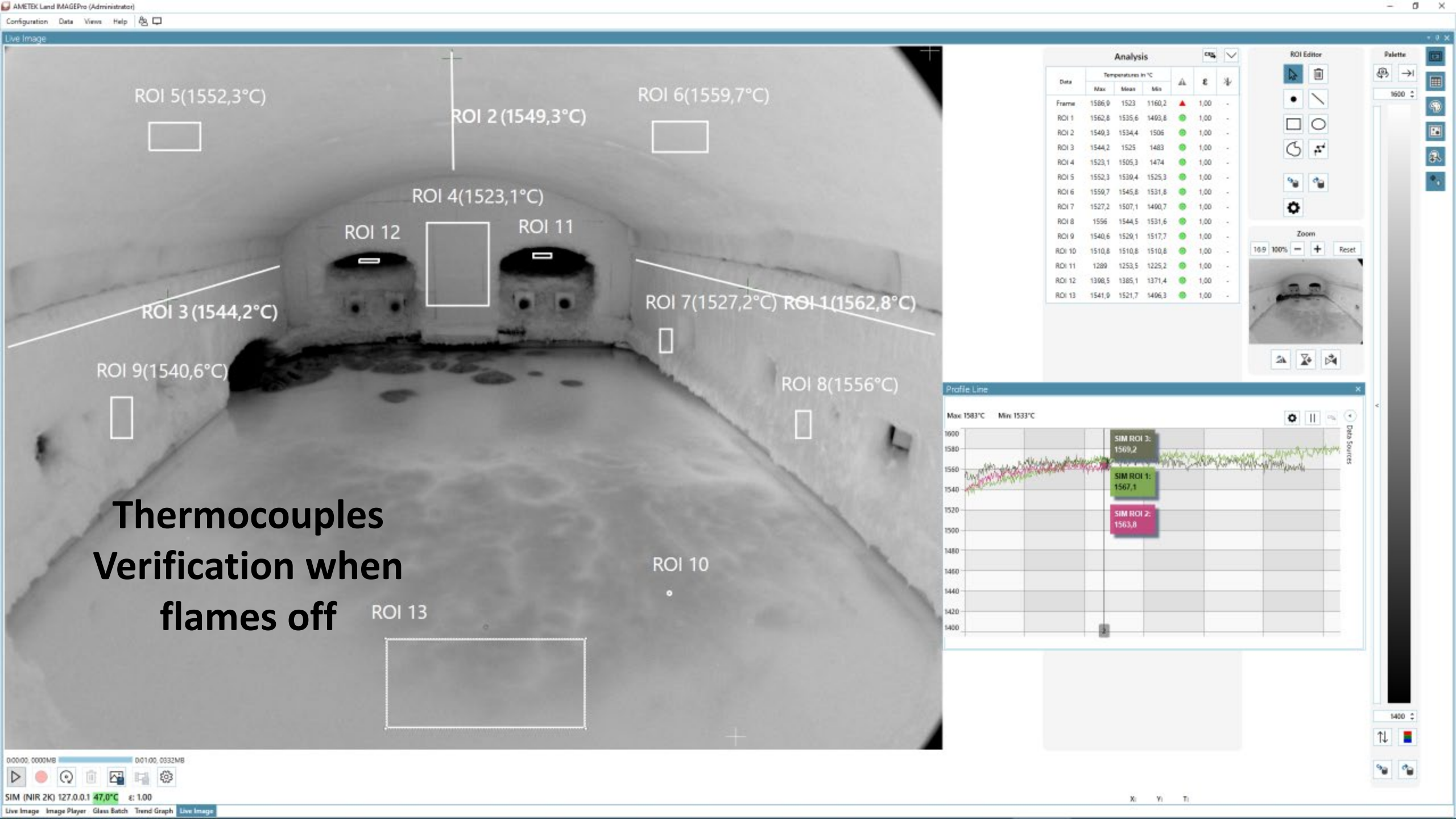
Remember the four Pillars of Benefits with Thermal Imaging NIR-B!
This is not only a pretty image!

Thermocouple Verification



Optical-Thermal profiles with hot spots

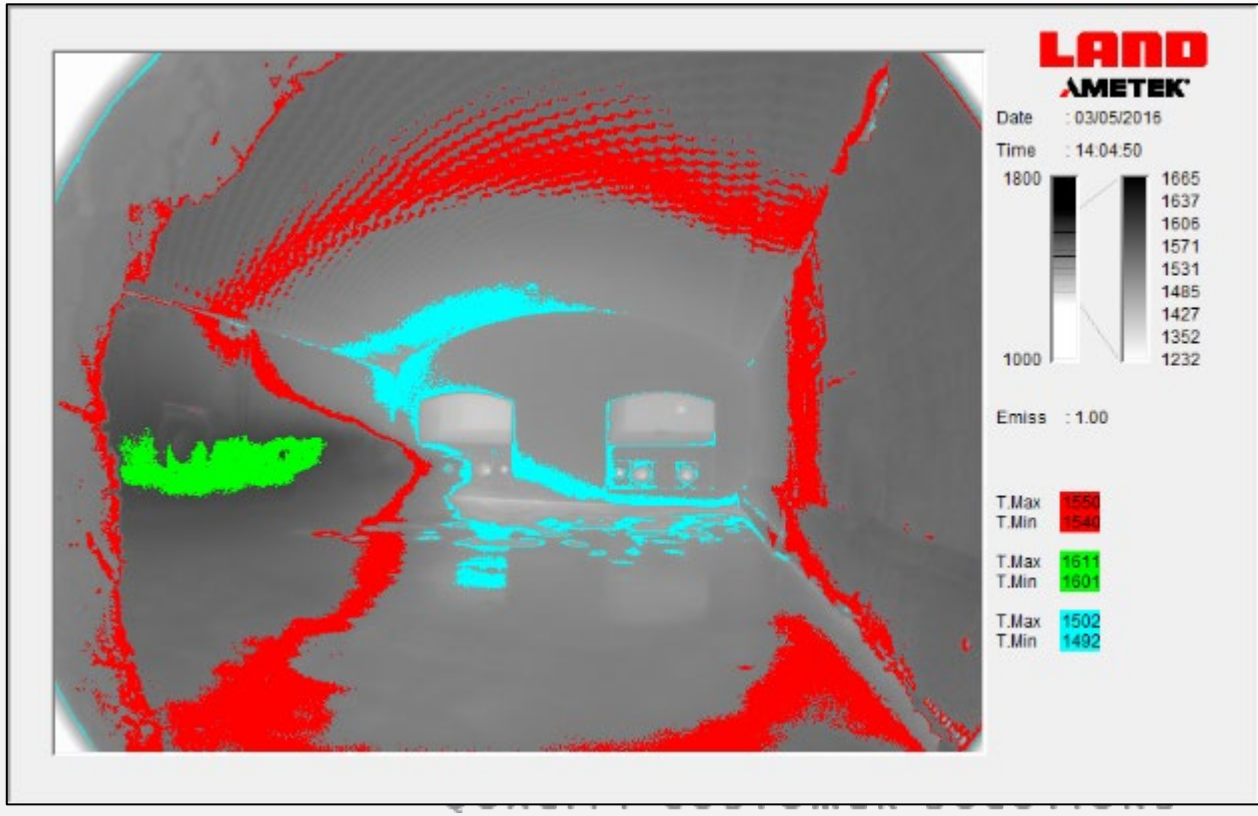



AMETEK Land IMAGEPro (Administrator)
Configuration
Data
Views
Help
Live Image
ROI 5(1552,3°C)
ROI 2 (1549,3°C)
ROI 6(1559,7°C)
ROI 4(1523,1°C)
ROI 12
ROI 11
ROI 3 (1544,2°C)
ROI 7(1527,2°C)
ROI 1(1562,8°C)
ROI 9(1540,6°C)
ROI 8(1556°C)
ROI 10
ROI 13
Thermocouples
Verification when
flames off
Analysis
ROI Editor
Palette
Zoom
Reset
Profile Line
Max 1583°C
Min 1533°C
SIM ROI 3:
1569,2
SIM ROI 1:
1567,1
SIM ROI 2:
1563,8
Data Sources
SIM (NIR 2K) 127.0.0.1 47,0°C
Live Image
Image Player
Glass Batch
Trend Graph
Live Image

Remember the four Pillars of Benefits of NIR-B

BW Palette for Air ingress and Batch pattern

Isotherms with 3 bands for hot and cold spot locations



FLAME SHAPE AND INTENSITY – MONO / RAINBOW / INTEGRATOR

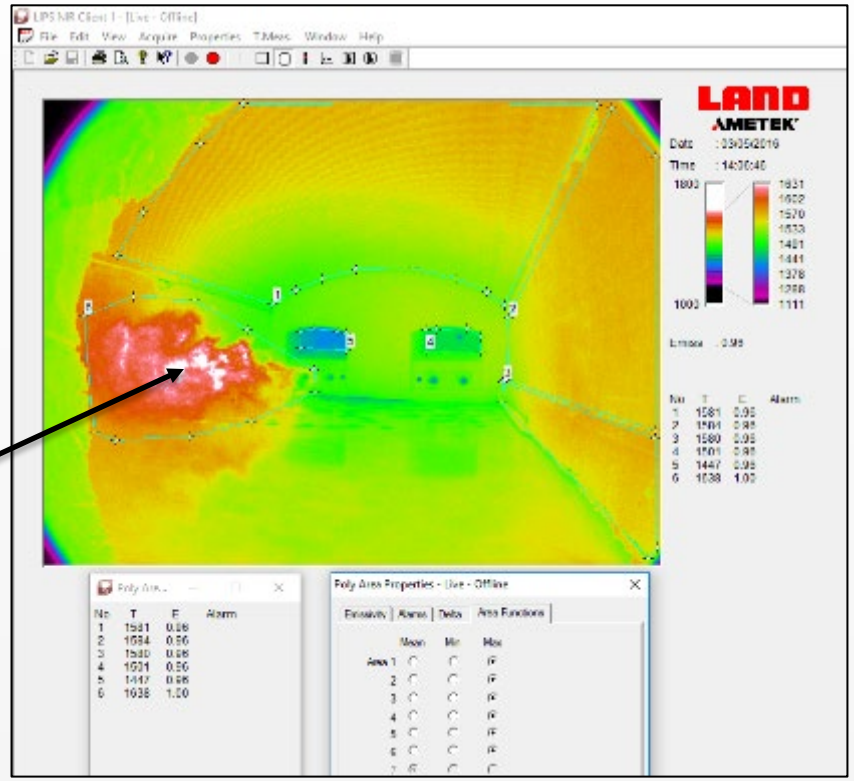
- Highlights flame shape and areas of high intensity for combustion and emissions optimisation.
- Continuous real time Temperature data.
- Areas used to monitor Highest or Average or Lowest Temperature.
- Crown, Regenerator and Side Wall temperature monitoring.

Nitrogen Oxide NOx formation

There are typically 4 modes of NOx formation:

- Fuel NOx – from Nitrogen elements in fuel
- Prompt NOx – relatively low temperature reaction
- Feed NOx – from raw ingredients such as Niter in the past
- Thermal NOx - at temperatures in excess of 1600°C

The upper limit of the NIR B is 1800°C areas above the upper limit are shown in white colour, by adjusting the range limits to increase contrast it is possible to determine what parts of the flame are the hottest and thereby assess generation of thermal NOx.



In glass manufacture as a result of modern batch materials typically the greatest source of NOx is believed to be thermal according is by Thermal NOx. At temperatures in excess of 1600°C (2900°F) the Oxygen molecules in air start to dissociate into elemental atoms. The higher the process or flame temperature, the higher the dissociation and therefore the greater formation of NOx. In the hottest zone of the flame a super equilibrium level of Oxygen atoms exists.

IMAGEPro GLASS

2.1

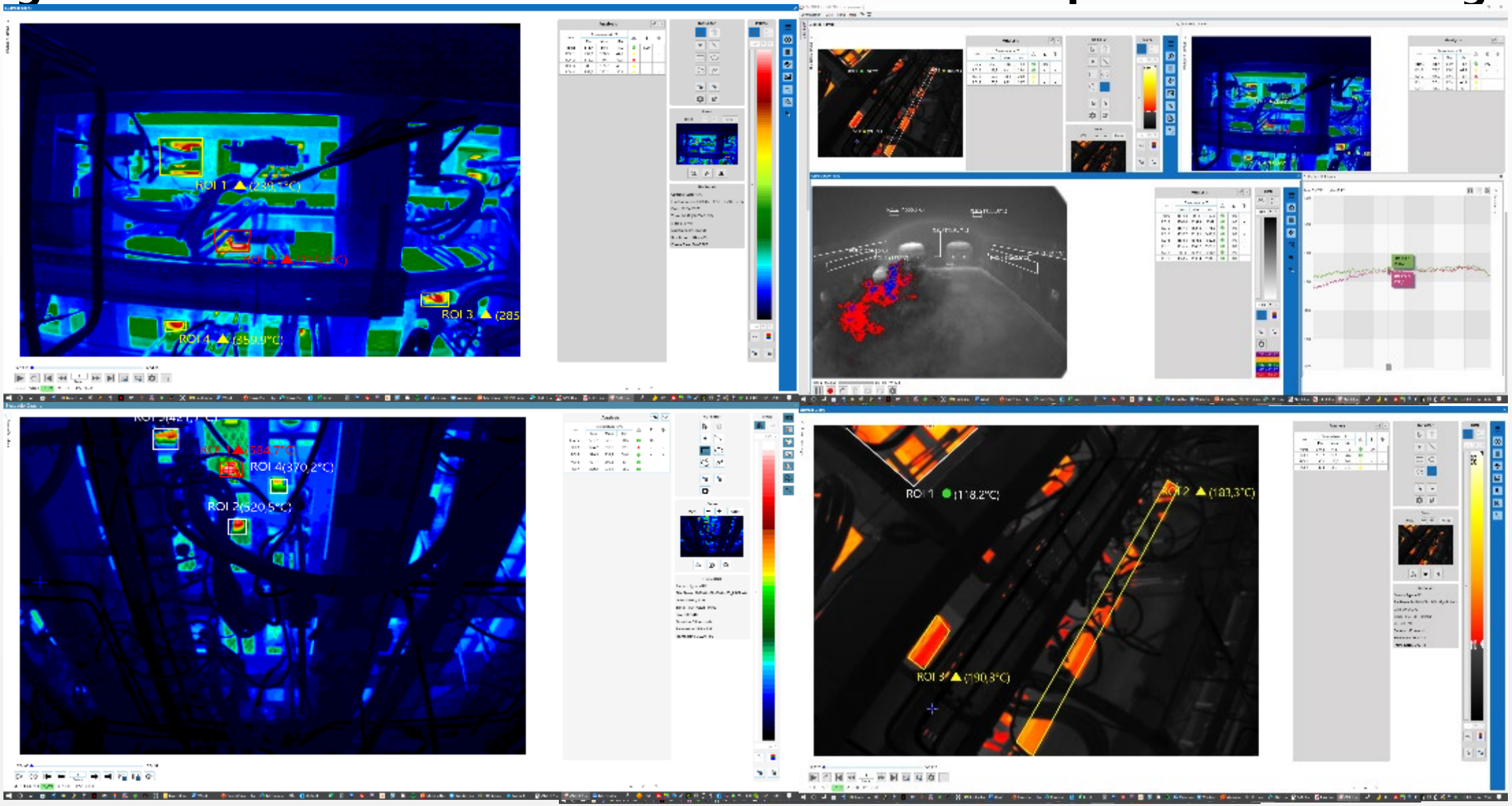
BATCH COVERAGE AND CROWN TEMPERATURES WITH NIR-B 2K GLASS AND IPV2

CONTAINER GLASS FURNACES

Image Pro– Gateway to Infrared Control

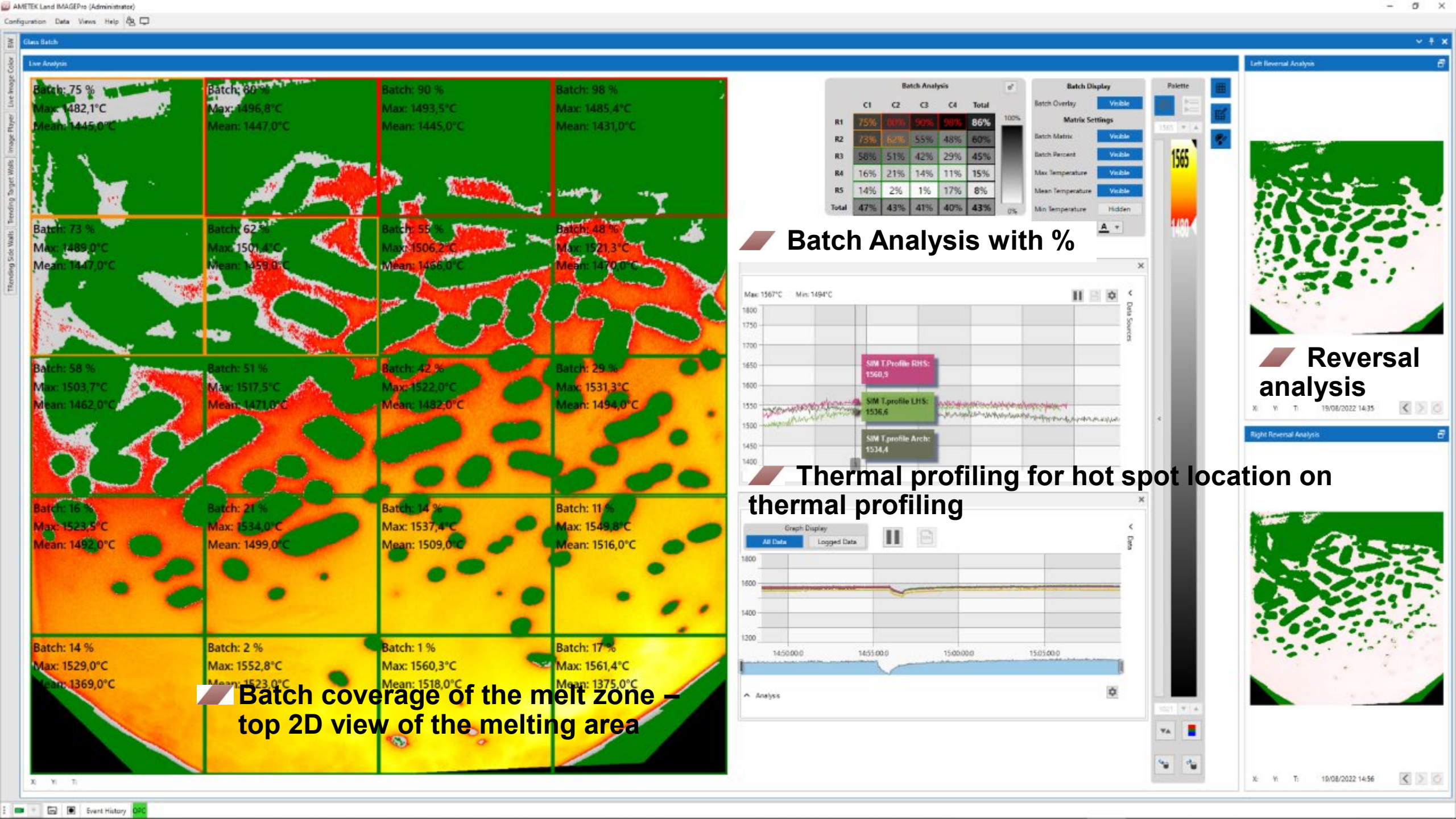
- Connection with all Land Instrument solutions including LWIR
- Digital and analogue Inputs/outputs
- TCPIP, OPC UA server, Modbus server and SDK
- Modbus server for data exchange with DCS (100 zones of interest possible to be monitored)+RTMP for video streaming
- Built-in Communication for Celsian rMPC (EU Reference)
- Built-in Communication for GS – ESIII (EU Reference)
- Any DCS communication for SCADA data analysis (Zenon Platform) with existing Drivers (TCPIP Modbus or OPC)

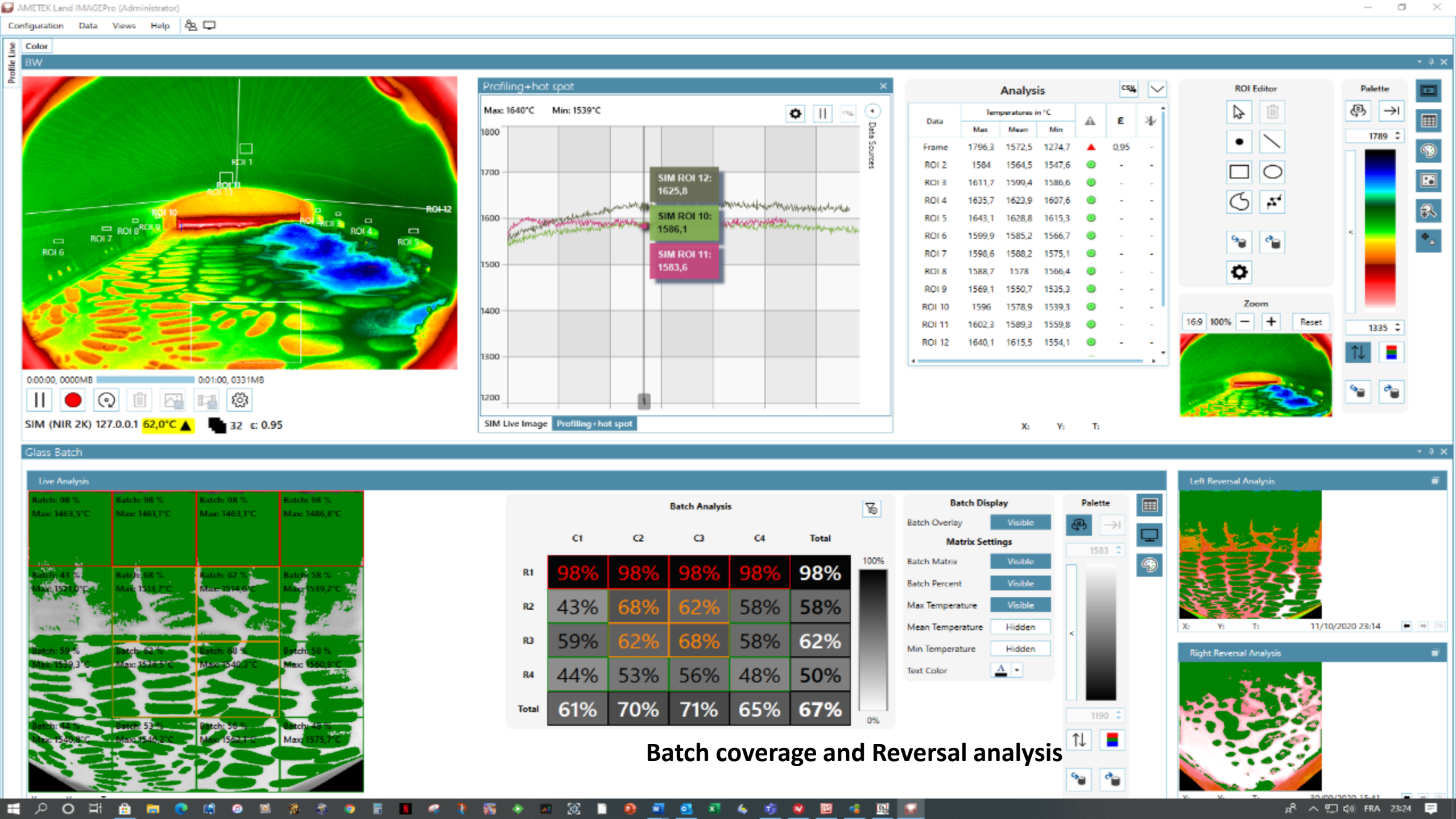
ImagePro 2.1 features for Glass leak detection and temperature monitoring



Batch Coverage and Crown Temperatures

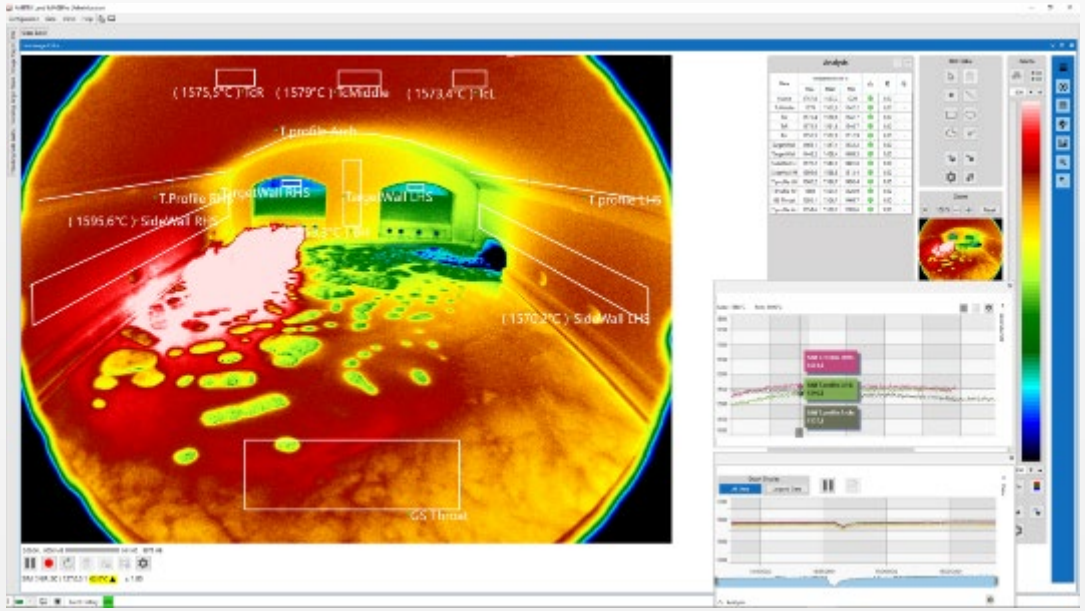
- Variation in Batch coverage has a direct impact on furnace temperatures . The temperature clearly drops when the batch moves to the front of the furnace. These ROIs can be used to set some alarms to the Furnace DCS and get a better efficient control of the batch coverage by adjustment of the batch charging direction:
  - Setting to have top 2D view of the melter with the Image Pro furnace configuration feature.
  - Setting of a ROI in front of the Throat.
  - Configuration of a Batch ROI in the coverage melting grid near the throat (ROIs in C4R2 for example).
  - Batch length can be adjusted.
- The Batch coverage in this critical ROI near the throat could be monitored to:
  - Avoid large amount (below 15%) of batch in this area even for large pull rates.
  - Prevent Glass Defects.

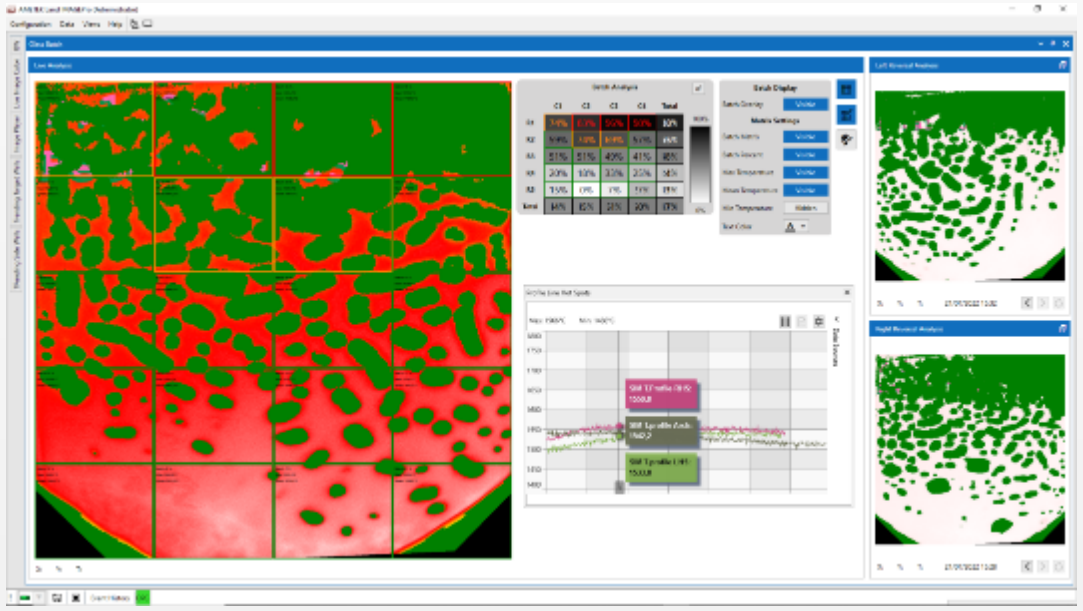

Batch coverage of the melt zone – top 2D view of the melting area
Batch Analysis with %
Thermal profiling for hot spot location on thermal profiling
Reversal analysis


AMETEK Land IMAGEPro (Administrator)
Configuration
Data
Views
Help
Color
BW
ROI 1
ROI 11
ROI 13
ROI 12
ROI 10
ROI 8
ROI 9
ROI 7
ROI 6
ROI 2
ROI 3
ROI 4
ROI 5
0:00:00, 0000MB
0:01:00, 0331MB
SIM (NIR 2K) 127.0.0.1 62,0°C
32 ε: 0.95
Profiling+hot spot
Max: 1640°C
Min: 1539°C
1800
1700
1600
1500
1400
1300
1200
SIM ROI 12: 1625,8
SIM ROI 10: 1586,1
SIM ROI 11: 1583,6
Data Sources
SIM Live Image
Profiling+hot spot
Analysis
Data
Temperatures in °C
Max
Mean
Min
ε
Frame 1796,3 1572,5 1274,7 0,95
ROI 2 1584 1564,5 1547,6
ROI 3 1611,7 1599,4 1586,6
ROI 4 1635,7 1623,9 1607,6
ROI 5 1643,1 1628,8 1615,3
ROI 6 1599,9 1585,2 1566,7
ROI 7 1598,6 1588,2 1575,1
ROI 8 1588,7 1578 1566,4
ROI 9 1569,1 1550,7 1535,3
ROI 10 1596 1578,9 1539,3
ROI 11 1602,3 1589,3 1559,8
ROI 12 1640,1 1615,5 1554,1
X:
Y:
T:
ROI Editor
Palette
1789
1335
Zoom
16:9
100%
Reset
Glass Batch
Live Analysis
Batch Analysis
C1 C2 C3 C4 Total
R1 98% 98% 98% 98% 98%
R2 43% 68% 62% 58% 58%
R3 59% 62% 68% 58% 62%
R4 44% 53% 56% 48% 50%
Total 61% 70% 71% 65% 67%
100%
0%
Batch Display
Batch Overlay Visible
Matrix Settings
Batch Matrix Visible
Batch Percent Visible
Max Temperature Visible
Mean Temperature Hidden
Min Temperature Hidden
Text Color
Palette
Left Reversal Analysis
11/10/2020 23:14
Right Reversal Analysis
Batch coverage and Reversal analysis
FRA
23:24

ImagePro Glass 2

- More Stable interface with possible multiple displays , Interface External Flame Detection
- Essentially the same as IPV1 Glass based on more reliable , quick and efficient IPV2 engine
- Batch analyser based on trapezoid geometry with flame detection

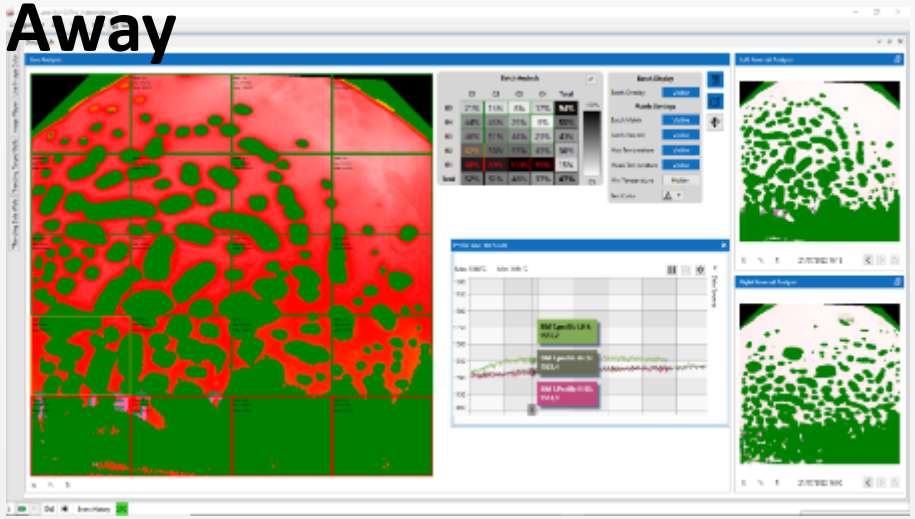




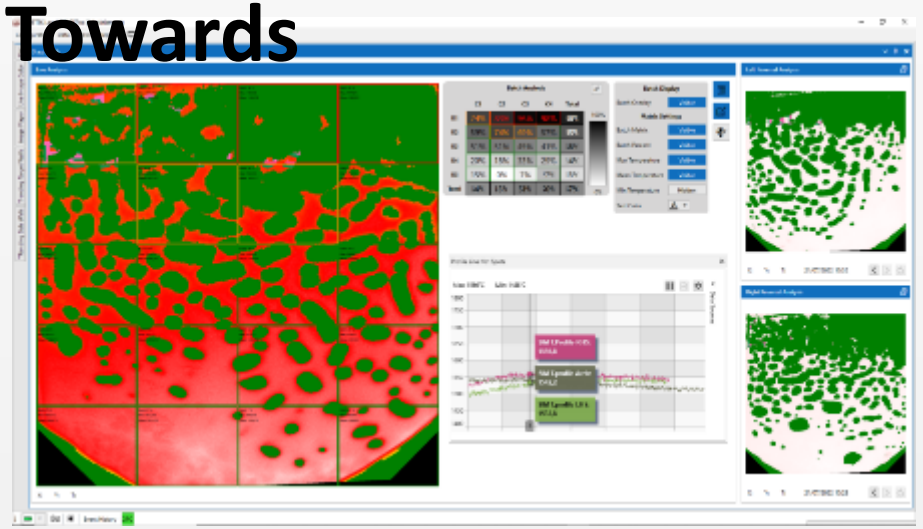
ImagePro2 Glass – new features

- **Flow Direction for multi locations**
  - Glass flow direction can be configured in furnace settings
  - **Towards :** Glass flow towards camera (existing)
  - **Away:** Glass flow away from camera
- If flow direction away from camera is selected then Batch display will be flipped

Away

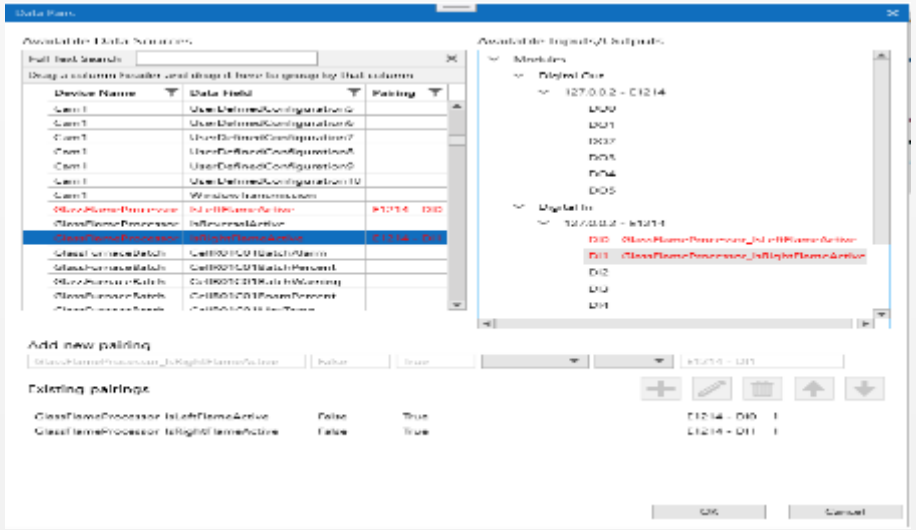


Towards

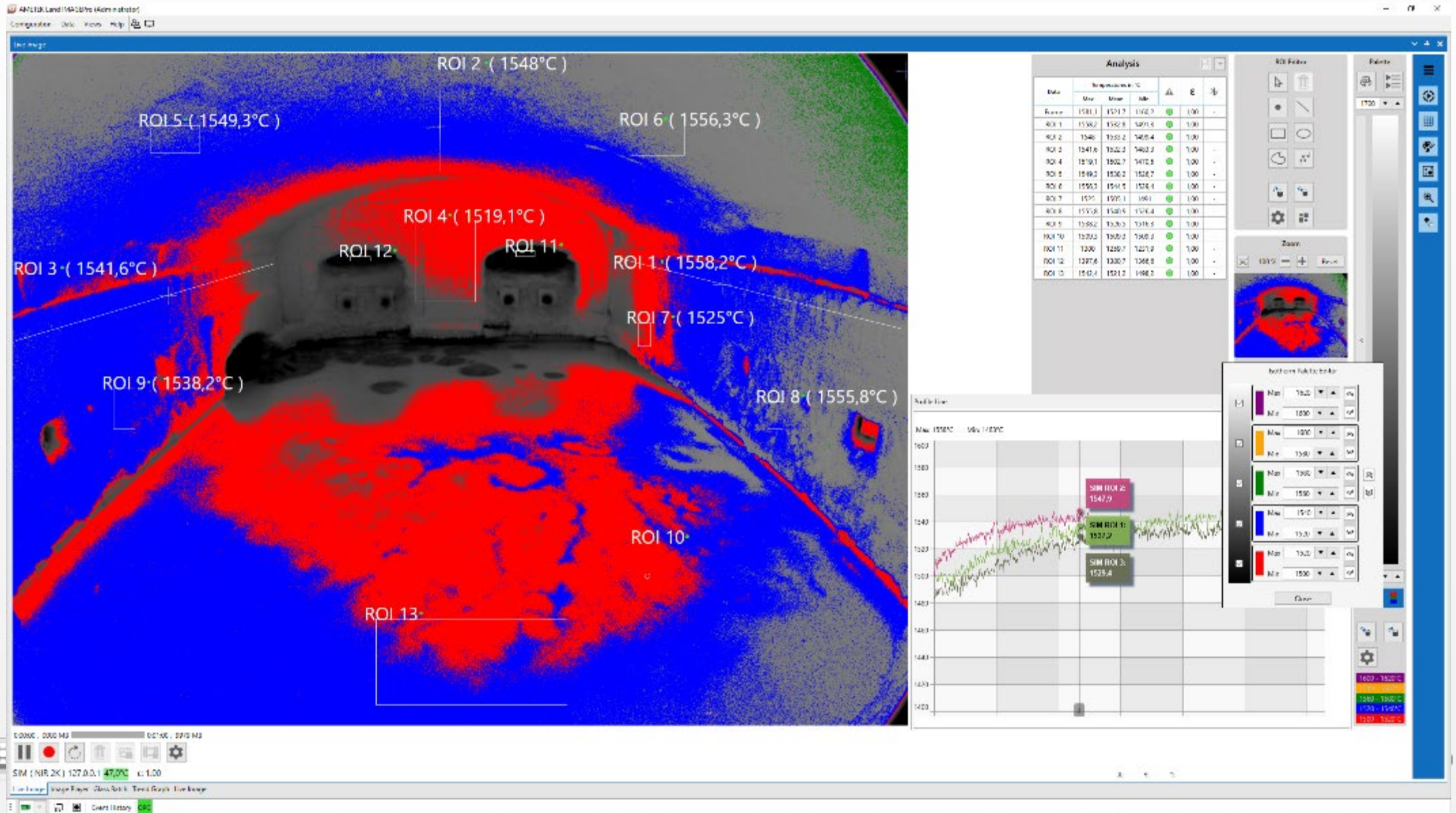


ImagePro2 Glass – new features

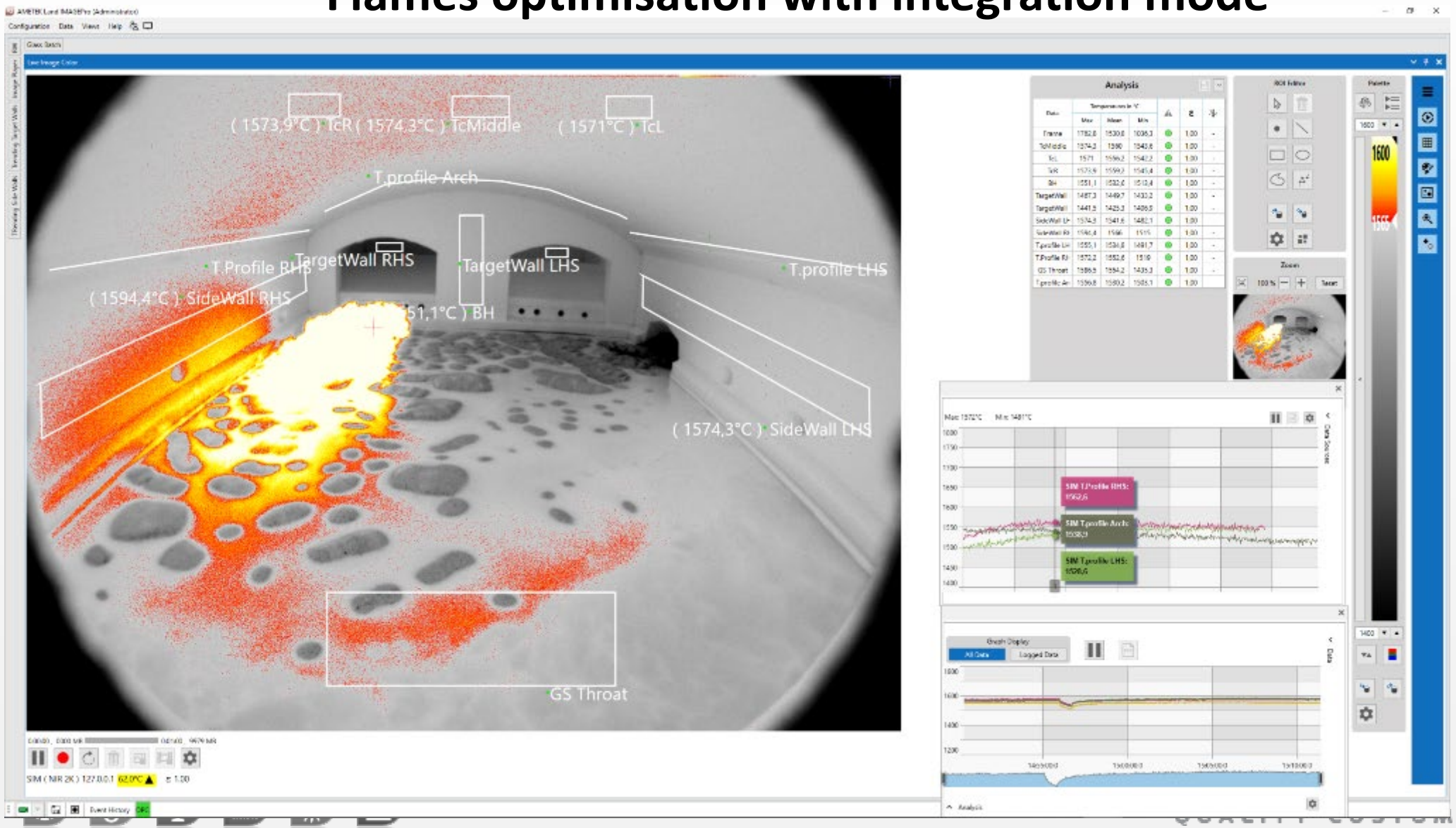
- **External Flame Detection**
  - There are now 2 types of flame detection (select in furnace settings)
    - Automatic
    - I/O
- Left and Right flame's status can be controlled from IO by data pairing the following tags
  - **IsLeftFlameActive**
  - **IsRightFlameActive**

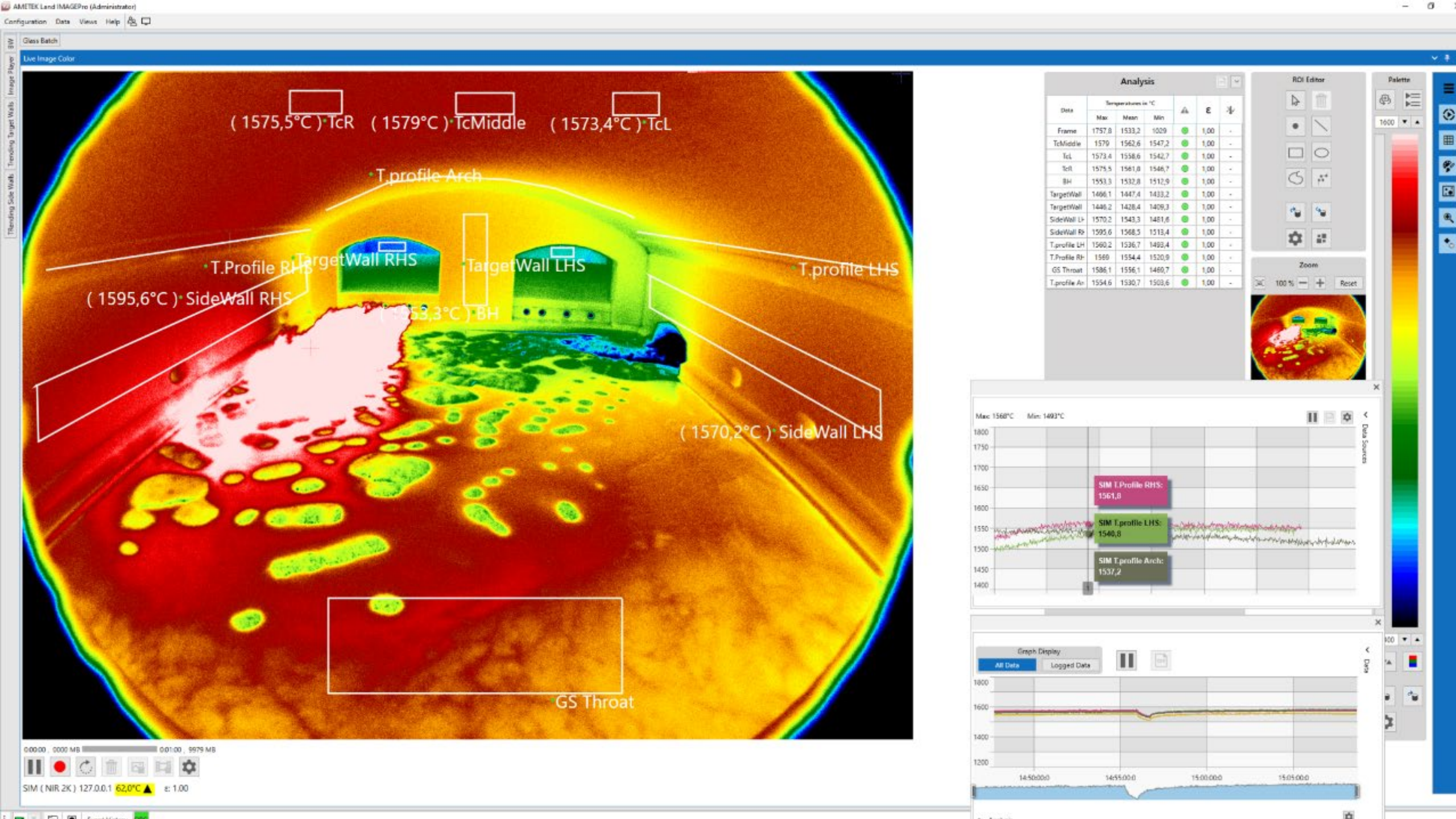


Isotherms


ROI 2 (1548°C)
ROI 5 (1549,3°C)
ROI 6 (1556,3°C)
ROI 4 (1519,1°C)
ROI 12
ROI 11
ROI 3 (1541,6°C)
ROI 1 (1558,2°C)
ROI 7 (1525°C)
ROI 9 (1538,2°C)
ROI 8 (1555,8°C)
ROI 10
ROI 13
Analysis

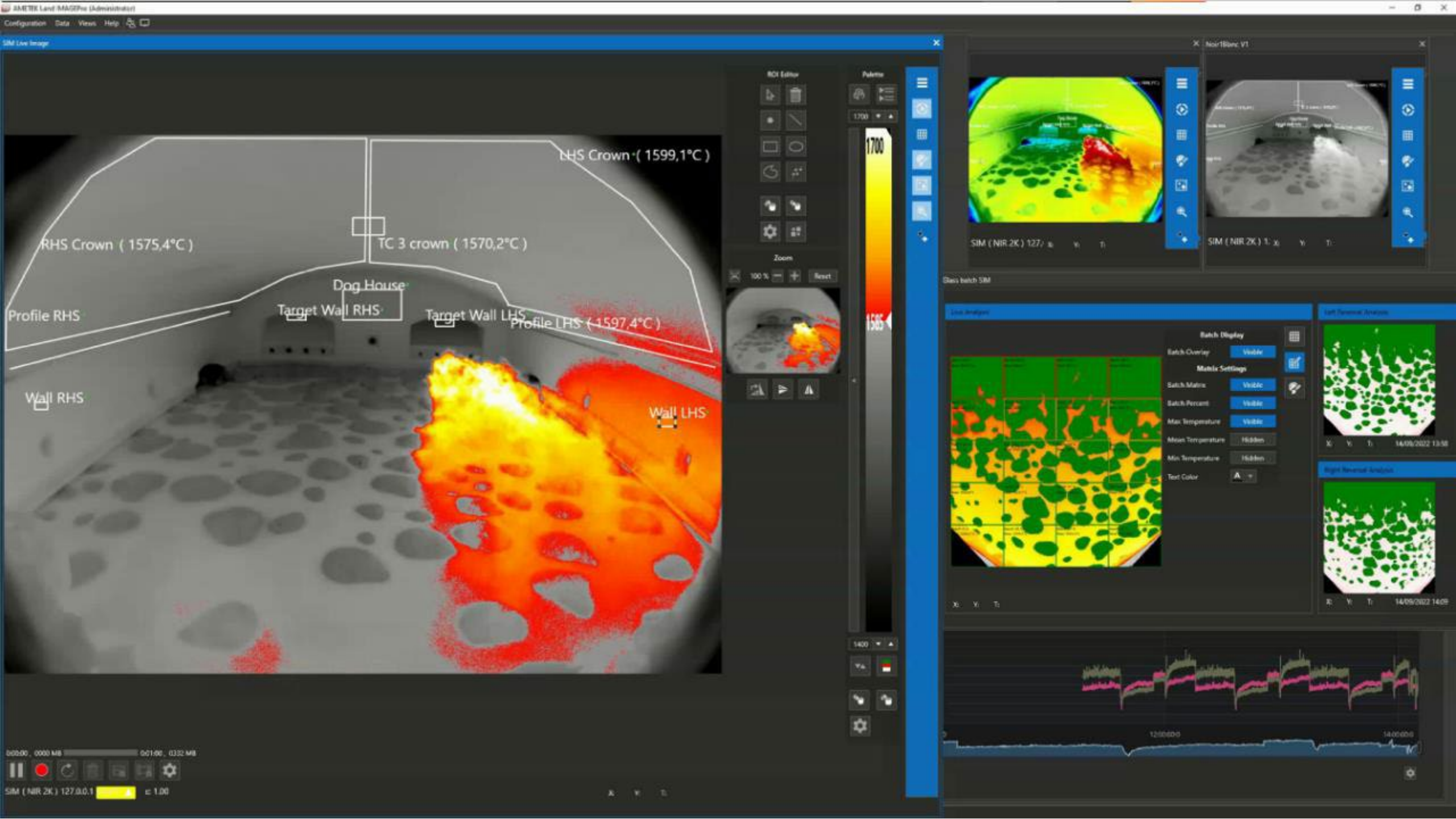
Flames optimisation with integration mode




AMETEK Land IMAGEPro (Administrator)
Configuration
Data
Views
Help
Glass Batch
Live Image Color
(1575,5°C) TcR
(1579°C) TcMiddle
(1573,4°C) TcL
T.profile Arch
T.Profile RHS
TargetWall RHS
TargetWall LHS
T.profile LHS
(1595,6°C) SideWall RHS
(1570,2°C) SideWall LHS
GS Throat
Analysis
ROI Editor
Palette
Zoom
Reset
SIM T.Profile RHS: 1561,8
SIM T.profile LHS: 1540,8
SIM T.profile Arch: 1537,2
Graph Display
All Data
Logged Data
SIM (NIR 2K) 127.0.0.1 62,0°C
ε: 1.00

Why to use NIR-B 2K on glass furnaces? Extended Benefits

- Possible Thermal Surveys with transportable NIR-B combining bundles Lancom 4 and Cyclops C100
  - Potential energy reduction with combustion optimization on every furnaces
  - Heat-up features at starting point with thermal references
  - Demonstration of recovery post repair with temporary oxy burners during repairs
  - Preventive maintenance
  - Needs to include this tool to best practices part of training sessions for optimisation
- Digitalisation with thermal distribution and bird eyes pictures
  - Potential to have data analysis for Expert System or SCADA through the furnace of the DCS (Zenon platform , Crowley Carbon or any data analysis solutions)
  - Existing communication with Expert system
  - Simple Batch control with Image pro Glass for basic analysis
  - Combustion and flames optimization for improved heat balance
- Traceability and Data for quality management
  - All furnaces images saved for future enquiries and reference points for quality controls
- Extended life of assets and improved daily furnace operations


LHS Crown (1599,1°C)
RHS Crown (1575,4°C)
TC 3 crown (1570,2°C)
Dog House
Profile RHS
Target Wall RHS
Target Wall LHS
Profile LHS (1597,4°C)
Wall RHS
Wall LHS
1700
1400
Batch Display
Batch Overlay
Visible
Matrix Settings
Batch Matrix
Batch Percent
Max Temperature
Mean Temperature
Hidden
Min Temperature
Text Color


LAND AMETEK
INDUSTRIES
PRODUCTS
AMECARE SERVICES
NEWS & EVENTS
ABOUT US
CONTACT US
Process Control & Product Quality
NON-CONTACT TEMPERATURE MEASUREMENT
Optimise the quality of finished product by providing live temperature information to the process control system.
Read More
AMETEK LAND AT A GLANCE
RECENT NEWS
EVENTS
DOWNLOAD OUR PRODUCT CATALOGUE
READ OUR LATEST E-MAGAZINES
DOWNLOAD OUR LATEST SOFTWARE
GOT A QUESTION? GET IN TOUCH
WWW.AMETEK-LAND.COM